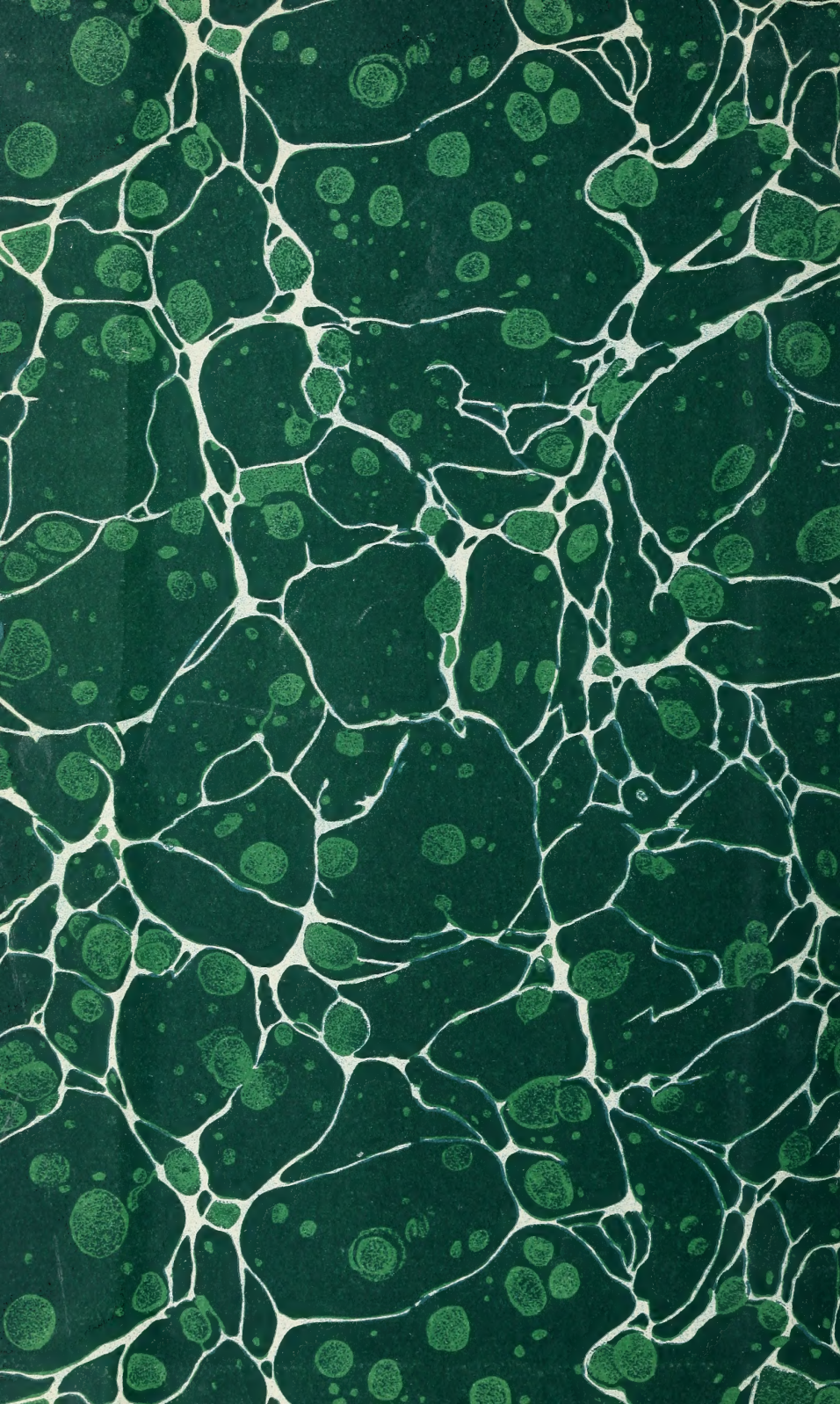
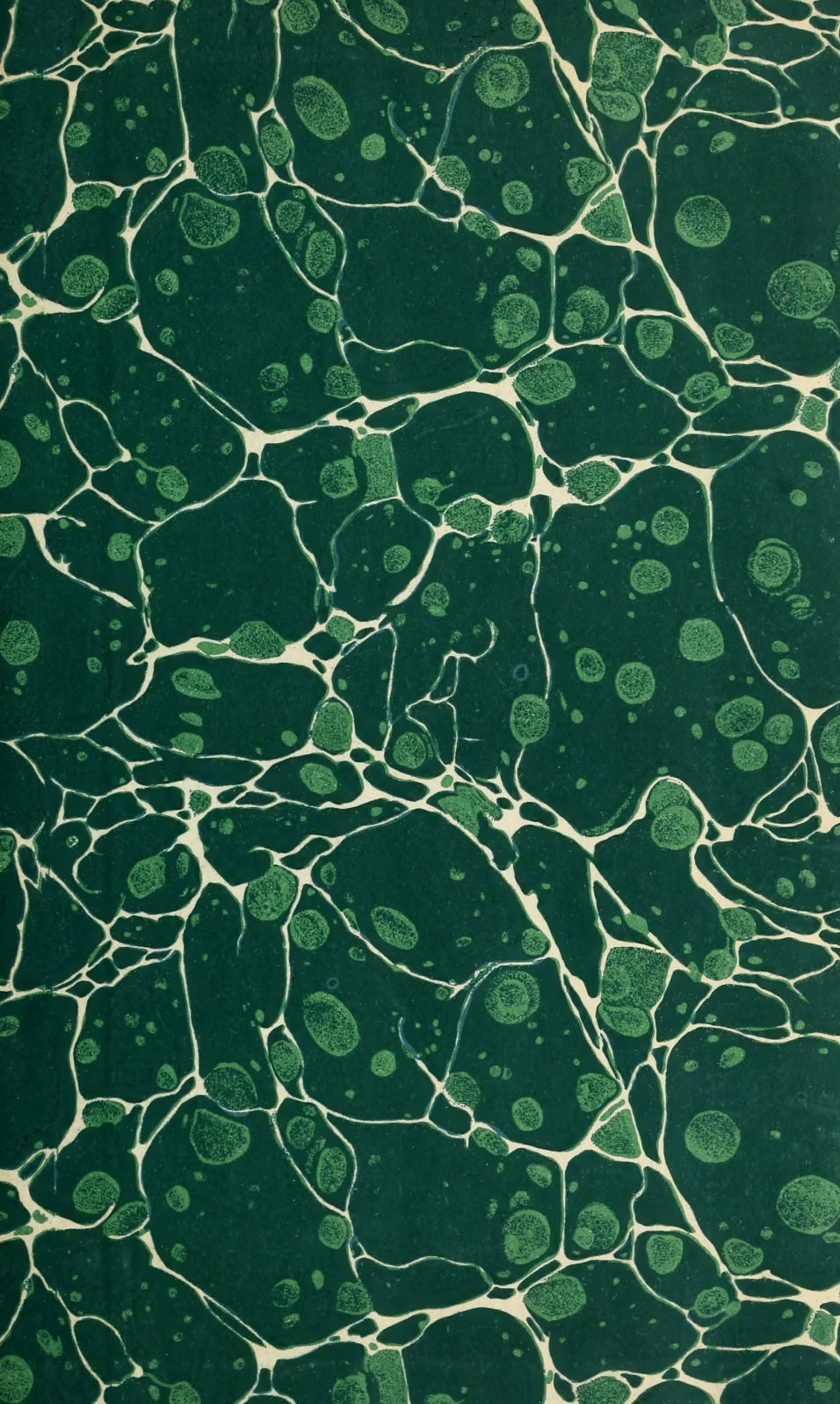


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NOTES ON THE HABITS OF CERTAIN COPROPHAGOUS BEETLES AND METHODS OF REARING THEM

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INTRODUCTION

Coprophagous beetles are of economic importance as well as of general interest, for several reasons: (1) By disturbing cattle dung, the breeding medium of the horn fly (*Haematobia irritans* L.), they probably reduce the abundance of this widespread pest of cattle; (2) many species are intermediate hosts of parasites of poultry and other animals; (3) they play an important role in the interchange of soils and the incorporation of organic matter; and (4) they exhibit the instincts of maternity and progeny protection. As there appeared to be a dearth of information on the habits of these dung beetles in this country and on methods by which these insects can be reared, the following notes and observations were made at Uvalde, Tex., from time to time from 1931 to 1934.

REARING METHODS

For rearing *Copris*, *Phanaeus*, and *Pinotus* in the laboratory, boxes containing sandy loam soil to a depth of 8 to 10 inches are used. The bottoms of the boxes are removed and the walls placed on floor boards 1 inch thick and held in place with cleats. By this arrangement the walls can be lifted from the cake of soil so that an examination can be made for the immature forms. A screen-wire top is necessary to keep the beetles from escaping. Heavy clay soils which will gum together when wet should be avoided. The soil should be kept moist and fresh dung supplied every few days. Apple boxes 18 by 12 by 12 inches are suitable for rearing *Copris* and *Phanaeus*, but longer boxes should be used for rearing *Pinotus*. *Canthon laevis* Drury can also be reared in these boxes, but since this

species needs considerable room for dung rolling an outside cage is more desirable.

Onthophagus can be reared in pint mason jars containing 2 inches of sand on which is placed a small quantity of dung. By emptying the jar every few days the parent beetles and the pellets of manure containing the eggs can be recovered.

The immature stages of *Aphodius* and *Ataenius* have not been studied in the laboratory, but they can probably be reared in fresh, uninfested cow dung on sand or soil in a small cage. They do not roll or bury dung, but pass their immature existence within the dropping.

HABITS OF VARIOUS COPROPHAGOUS BEETLES

COPRIS REMOTUS Lec.

This coprophagan makes its burrow at the margin of dung. Cattle droppings are usually utilized, but on one occasion a burrow was found at the edge of carnivore dung, and at another time several burrows were examined near the contents of the paunch of a sheep carcass. After a burrow has been excavated, the beetle grasps a small portion of dung with its fore legs and backs down into the tunnel, returning in a few minutes to repeat the procedure and continuing for one-half to 2 days. The beetles are very cautious, and movements of the observer cause a quick retreat into the tunnel.

The female makes 2 types of burrows, 1 for feeding and 1 for rearing progeny. If the dung is to be used for adult food, it is shaped into a ball an inch or less in diameter and placed in a circular cavity at the lower end of a 4- to 8-inch burrow, similar to that made by *Copris tullius* Oliv.¹ The cavity for the rearing of progeny is much the same except that it is larger, deeper in the ground, and a larger portion of dung is shaped or kneaded into a flat mass about 1 inch thick and 2 to 3 inches in diameter. From this mass are constructed the ovoid to spherical egg balls, the diameters of which average 1 inch and three-fourths inch. The balls are formed one at a time and the entire procedure requires 2 to 3 days. From 1 to 8 egg balls have been found in a nest, but the usual number is 4 to 6 (fig. 1). Whenever the nests of this species were examined, the female beetle was invariably in the cavity with her progeny. Further study revealed that after oviposition is completed she plugs the opening to the tunnel and remains with her progeny, hovering about and over the balls until the larvae complete development and emerge as adults.² After about 2 weeks the balls were very smooth and had no ragged surfaces such as are characteristic soon after construction. Apparently the beetle occupies her time in polishing and caring for the balls and probably guards against possible enemies. Fresh dung was frequently put in the box, but the beetle

¹ LINDQUIST, A. W. AMOUNT OF DUNG BURIED AND SOIL EXCAVATED BY CERTAIN COPRINI (SCARABAEIDAE) (I). Jour. Kans. Ent. Soc. 6: 109-125, illus. 1933.

² Similar observations on *Copris hispanus* L. were made in Europe by Fabre as reported in the following publication: FABRE, J. H. SOUVENIRS ENTOMOLOGIQUES . . . ÉTUDES SUR L'INSTINCT ET LES MOEURS DES INSECTES. v. 8, pp. 128-150. 1897. Fabre's account was included in a translation of some of his works, by Teixeira de Mattos: TEIXEIRA DE MATTOS, A. [L.] THE SACRED BEETLE AND OTHERS, BY J. HENRI FABRE. 425 pp. New York. 1924. This apparent parental care was observed in the case of *Scarabeus sacer* L. in Corsica. GOODMAN, A. DE B. OBSERVATIONS ON THE LIFE-HISTORY OF SCARABEUS SACER. So. London Ent. and Nat. Hist. Soc. Proc. 1927-28: 42-47. [1928.]

could not be induced to leave her brood. If the balls are taken away and the nest is destroyed, the beetle usually begins another home immediately, but she may construct feeding burrows for a few weeks first. One female was taken from her brood and placed on top of the soil in the box, but she seemed to make no effort to find her progeny, and several days later was found in a feeding burrow. When the egg balls were removed from a nest and put on sand in salve boxes, they matured normally.

In a test in which the egg balls were taken from a female shortly after their construction, 6 nests, containing a total of 24 eggs, were constructed successively from May 10 to July 26. In another test, 12 nests, containing a total of 41 eggs, were obtained from a reared female over a 14-month period. As a check in this test a female in another box was allowed to stay with her progeny for long periods, but this female constructed only 5 nests, containing a total of 15 eggs. It appears that in the field only 3 or 4 broods normally are produced by one female in a year, but in the laboratory from 6 to 10 broods can be obtained by removing the progeny.

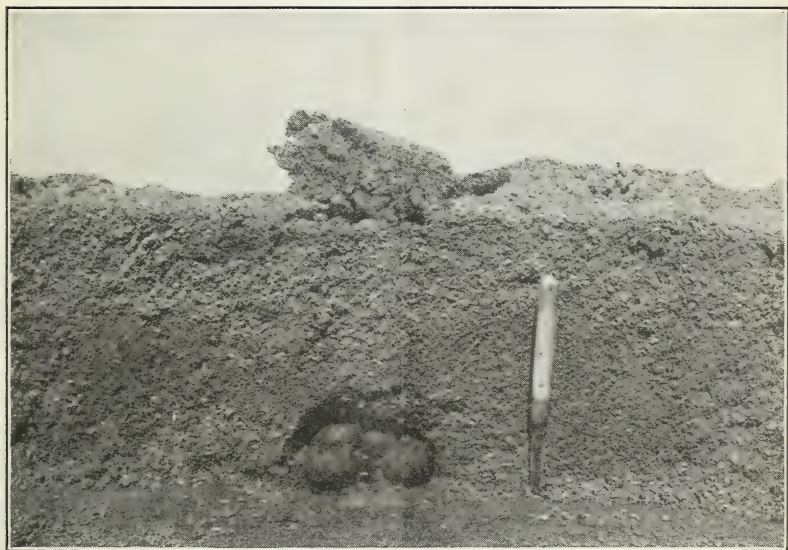


FIGURE 1.—Brood chamber of *Copris remotus*. Usually from 4 to 6 egg balls are made in one chamber.

The egg is usually, but not always, located at one of the longitudinal poles of the ball. A slight elevation indicates the point at which an egg will be found in a small, smooth depression just under the surface. The egg is elongate, slightly curved, rounded at both ends, smooth, and glistening white with a very faint green tint. The average diameters are 4.33 by 2.90 mm.

It is somewhat difficult to determine exactly the length of the incubation period, but it appears to be from 5 to 10 days under laboratory conditions. The period of development from egg hatching to adult emergence in the spring and summer averaged 49 days,

with a range of 38 to 69 days. The pupal period ranged from 12 to 37 days. Of 48 reared beetles 32 were females and 16 males.

To determine the number of larval instars and the time in each instar it is necessary to open the ball, remove the larva for measurement of the head capsule, replace the larva, and repair the ball, which after a number of examinations may become ragged and weak. It was nearly impossible to find the cast skins except immediately after molting. Three larval instars were found, and the data concerning them are shown in table 1.

TABLE 1.—*Data on instars of three dung beetles*

Species	Instar	Time in instar			Measurement of head capsule		
		Maximum	Minimum	Average	Maximum	Minimum	Average
		<i>Days</i>	<i>Days</i>	<i>Days</i>	<i>Mm</i>	<i>Mm</i>	<i>Mm</i>
<i>Copris remotus</i>	First.....	4	2	2.9	2.1	1.8	1.97
	Second.....	5	2	3.7	2.5	2.2	2.35
	Third.....	(¹)	(¹)	(¹)	3.0	2.8	2.94
<i>Phanaeus triangularis</i>	First.....	6	3	4.1	2.8	2.5	2.66
	Second.....	4	4	4.0	3.2	3.0	3.10
	Third.....	(¹)	(¹)	(¹)	4.2	4.0	4.12
<i>Canthon laevis</i>	First.....	3	1	1.8	2.2	2.0	2.10
	Second.....	3	2	2.5	2.8	2.4	2.65
	Third.....	(¹)	(¹)	(¹)	3.2	2.9	3.13

¹ Not determined.

Eggs have been obtained as early as March 20, and as late as October 10.

The longevity of the adult is interesting. One reared female lived 644 days, and several beetles have laid eggs over two seasons. Under normal conditions females probably live 4 years and possibly longer. Since the parent stays with her progeny until they emerge as adults, only 3, or sometimes possibly 4, batches of eggs are laid in a year. Twelve batches have been obtained from a single female during a 14-month period without a decrease in number of eggs per batch, when the progeny were taken away from the nest from 5 to 14 days after deposition, and it seems reasonable to suppose that 4 years would normally be required to lay 12 batches of eggs.

PHANAEUS TRIANGULARIS (Say)

The burrows of this beetle have never been found on the plains around Uvalde, but after rains they have been observed about 30 miles north of Uvalde on the escarpment of the Edwards Plateau, but only in the river valleys. Although the river bottoms close to Uvalde have been searched, only one burrow has been discovered. Apparently the species seeks localities close to streams and does not thrive in hot, dry plains.

This species also burrows at the edge of cattle droppings. In the field these burrows have been found to be branched, the main tunnel being from 6 to 12 inches long and about three-fourths inch in diameter, and the branch, which is used for dung storage, from

3 to 8 inches in length and 1 inch in diameter. Eggs have not been found in the field.

In the breeding boxes the egg chamber is always deeper in the soil than the feeding tunnels. Dung is taken down into a cavity about $1\frac{1}{2}$ to 2 inches in diameter and formed into a single, nearly perfect sphere. The surface of the dung ball is then plastered with soil to a thickness of nearly one-fourth inch except at one point, where it is applied more thickly, giving the ball a pyriform appearance (fig. 2). This coating of soil probably prevents excessive desicca-

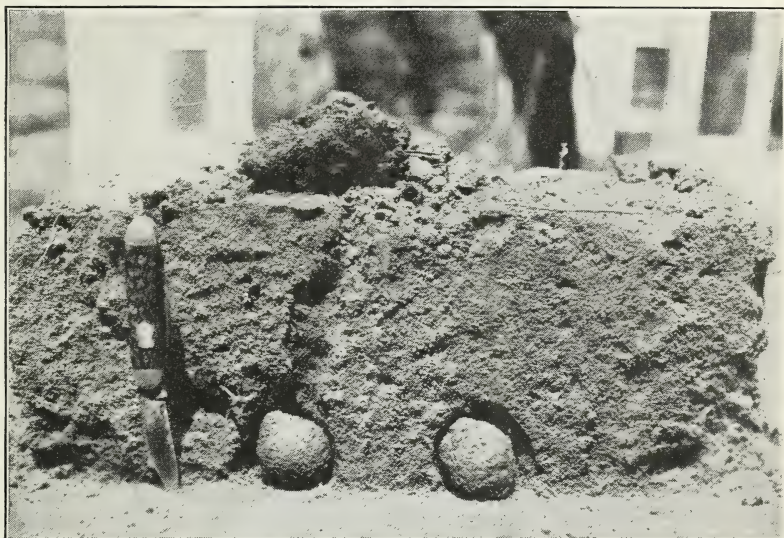


FIGURE 2.—Completed egg balls of *Phanacus triangularis* in their individual chambers.

tion of the larval food. The egg is laid in the smaller end of the ball, just under the surface, in a small earthen cell or cavity. The earthen cap is somewhat rounded and often contains a tiny hole. The egg is not in contact with the manure, as in the *Copris* ball, and when the egg hatches the larva digs its way into the interior and feeds on the food provided by the parent. That this stocky, clumsy beetle is able to build such a beautiful ball, construct the smooth egg cavity, and cap it without crushing the fragile egg is indeed marvelous. The egg balls are more nearly uniform in shape and more symmetrical than are those of *Copris*. When the egg ball is completed, the beetle leaves to construct another, and apparently the progeny is forgotten. Several days are required to dig a burrow and construct the egg housing.

The egg is similar to that of *Copris*, but larger, the diameters being approximately 6 by 4.3 mm. It is elongate, subcylindrical, and glistening white. The incubation period is from 6 to 9 days.

Two females taken in the field and kept together in a box laid 34 eggs from May 20 to October 2, 1932. Unfortunately, the beetles died during the extremely cold weather in February 1933. Egg deposition would probably have continued into the following summer.

A group of reared specimens which emerged in May and June 1933 did not commence oviposition until September.

For a study of the immature stages the egg balls were placed singly on slightly moistened sand in pint mason jars capped with solid tops. Of 24 specimens that were reared, 18 were females. There seems to be not more than one generation a year. The average period from egg hatching to adult emergence was 344 days, with a minimum of 269 and a maximum of 391 days. The eggs deposited in September produced adults only a few days later than those laid in May. The pupal period ranged from 37 to 50 days. Three larval instars were found, and the data are shown in table 1. When the larva was a few weeks old, the inner ball of dung had shrunk and the surrounding husk of soil was easily broken. The fully developed larva constructed a spherical, creamy-white cell inside the ball.

When the ball was opened slightly, the larva ejected into the hole an anal paste which, when dry, formed a hard, cementlike plug. This process of repair has been observed with other species of dung beetles.

An interesting observation pertaining to feeding habits was made of a male of *Phanaeus triangularis* in a breeding box January 29, 1933. The insect was feeding at the margin of a patch of dung, and several observations daily showed a continuous consumption of food and a constant ejection of feces until a string several feet long had accumulated. Approximately 2 cubic inches of dung was consumed in 7 days.

CANTHON LAEVIS (Drury)

This species is widely distributed, and its actions in carving out and rolling away balls of dung are frequently observed. At times, particularly after rains, two dozen or more beetles may be seen cutting up a dropping, and sometimes the entire dung patch is destroyed. In hot, dry weather 50 to 100 beetles may be found milling around inside a dropping. One unusually large dropping was estimated to contain 600 beetles. The insects probably congregate in this manner for feeding and protection until they are ready to prepare for their progeny.

Canthon laevis females roll away and bury balls of dung for food and for egg deposition. The greatest activity is in the spring, and very little rolling has been observed in the fall. When it has rolled a ball about for an hour or more and found a place for burial, the beetle begins to dig under and around the sphere until it gradually disappears into the hole. Upon excavation a few days later the beetle's exit tunnel is found extending down to a depth of 2 to 5 inches, where the ball is lying in a neat spherical cavity; or, if the dung ball is used for adult food, the beetle may be found feeding on the manure and the material reduced to shreds. In either case the ball is from five-eighths to nearly 1 inch in diameter, including the coating of soil which has been accumulated in the rolling process. In her underground chamber the female apparently finishes the ball by applying an additional coating of soil at some point for the egg cavity or cell, making it pyriform in shape.

When conditions are optimum, hundreds of earthen mounds covering the burrows of these beetles can be seen within a few hundred yards. In one pasture 50 mounds were found on a $\frac{1}{20}$ -acre plot and at another place a count on a $\frac{1}{12}$ -acre area showed 168 mounds.

The egg is creamy white and similar to other dung-beetle eggs; the average diameters are 5.45 and 3.60 mm. The incubation period is 4 to 8 days and the pupal period 10 to 14 days. The egg balls used for study of immature stages were obtained by digging up nests in the field immediately after rains.

The average developmental period from egg hatching to adult emergence at the laboratory in the spring and summer was 35.4 days, with a minimum of 29 and a maximum of 44 days. There are indications that in the field the developmental period is shorter. Three larval instars were found, and the data are shown in table 1.

The larvae of this species, as well as of *C. lecontei* and probably other species of *Canthon*, at intervals make holes in the smaller end of the ball and excrete a black, moist, pasty mass, which soon hardens and forms a collar of protruding nodules around the small end of the ball. The excreta may occasionally be found on other parts of the ball.

CANTHON LECONTEI Har.

This species, although much smaller than *C. laevis*, has similar habits. The beetles are abundant in the spring and occasionally are very active in October. The ball they construct and roll is from one-fourth to three-eighths inch in diameter and is buried from 1 to 3 inches in the ground. The incubation period is 4 to 6 days. In June the period from egg hatching to adult emergence averages 24.3 days.

CANTHON CYANELLUS Lec.

Although this species is fairly abundant at Uvalde, the eggs or immature stages have never been seen. The beetles are found in cow droppings but most abundantly at meat baits. They are attracted to the meat baits in blowfly traps, and often 25 or more are drowned in the bait pans. They have been observed at small carcasses and human excrement. A beetle was once seen rolling a ball that had been carved from a piece of decaying liver.

ONTHOPHAGUS ANTHRACINUS Har.

Specimens of *Onthophagus anthracinus* Har. are found in dung from March to December, and a hundred or more have been counted in a single dropping. Species of *Onthophagus* perform their dung burial under a dropping. A burrow is dug vertically into the ground to a depth of 1 to 4 inches, and dung is transported into the lower extremity, where it is fashioned into a crude ball in which an egg is laid.

Reared females have deposited from 43 to 67 eggs over periods of 22 to 42 days. Only 1 or 2 eggs are laid daily, and they average 1.56 by 0.74 mm in diameter. The average developmental period from egg to adult in summer was 38.4 days, with a range of 36 to 52 days. Notes on the number of instars are not complete, but indications are that there are three.

ONTHOPHAGUS PENNSYLVANICUS Har.

This species is common at Uvalde and has a wide distribution over the United States. Its habits appear to be similar to those of *O. anthracinus*, but the egg and ball are smaller. A few specimens have been reared, and the developmental period is about the same as that of *O. anthracinus*.

PINOTUS COLONICUS (Say)

This species, the largest of the dung beetles studied, has been found only north of Uvalde. The burrowing habits in the field are similar to those of *P. carolinus* (L.) previously described by the writer.³ Three beetles from the field were obtained in the summer of 1932, and two of these died the following spring. The remaining beetle laid five eggs before an accident caused her death. The egg is deposited in a mass of manure, which has the appearance of being pushed into a shapeless cavity branching away from the tunnel. The egg is enormous, about one-half by one-fourth inch in diameter. There is apparently only one generation a year.

APHODIUS spp. and ATAENIUS spp.

These species deposit their eggs in dung, and the larvae develop within the droppings. *Aphodius lividus* (Oliv.) is abundant at Uvalde, on one occasion 1,113 specimens being counted in a cow dropping. Adults have been observed during the winter in the field. The developmental period has not been determined, but it is indicated from collections in caged cow droppings that 25 to 45 days is required.

THE ATTRACTION OF COPROPHAGOUS BEETLES TO CARCASSES AND MEAT

In southwestern Texas dung beetles, particularly *Canthon laevis*, are commonly seen in bait pans of blowfly traps. From a few to several hundred dead beetles are often found in the water in bait pans. The following species have been found in bait pans:

<i>Canthon laevis</i>	Very abundant.
<i>Canthon lecontei</i>	Do.
<i>Canthon cyanellus</i>	Abundant.
<i>Phanaeus triangularis</i>	Occasional.
<i>Copris remotus</i>	Do.
<i>Onthophagus</i> spp.....	Do.

Many species of dung beetles have been taken at meat baits over the southern part of the United States, and they are occasionally observed at small carcasses. The beetles are probably attracted to the meat by the odor. Meat may serve as food for the beetles, but it is not necessary in breeding them at the laboratory.

COPROPHAGOUS BEETLES AS A NATURAL CONTROL OF THE HORN FLY

The species principally responsible for dung dispersal in southwestern Texas are *Canthon laevis*, *Phanaeus triangularis*, and *Pinothus colonicus*. At times, particularly in springs when the rainfall

³ LINDQUIST, A. W. See footnote 1.

is plentiful, large quantities of cattle droppings are disturbed by these beetles. No comparative data are at hand on the effect of these insects on horn-fly breeding, but probably fewer horn flies would mature in a dropping that is nearly destroyed. The following observations indicate what sometimes occurs: On April 30, 1932, 12 fresh droppings were examined west of Uvalde, and they were all from one-half to almost totally disintegrated by *C. laevis*. On May 1, 1932, 100 fresh droppings were examined north of Uvalde, and three-fourths were from one-half to almost totally destroyed, in some cases only a cubic inch of dung remaining. In the second instance *C. laevis*, *P. triangularis*, and *P. colonicus* were responsible for the dispersal of dung. The disturbing of droppings by the smaller species of dung beetles in order to hasten desiccation probably causes an unfavorable condition for the horn-fly larvae. There are, however, long periods when the larger species are not active in the field, although activity is fairly constant in the breeding boxes.

Frequent rains and high humidity increase the activity of these insects, particularly in the spring and summer. It is suspected that in long dry periods large numbers of the beetles are killed as they are ready to emerge from their cells, the balls becoming hard and imprisoning these insects.

Consideration has been given to the possibilities of artificial encouragement of certain of these insects with an objective of horn-fly control, but it is believed at present that efforts along other lines, especially with reference to the parasites of horn flies, would be more productive.

SUMMARY

In order to study the habits of coprophagous beetles more closely than was possible in the field, several species were reared in the laboratory by placing females in boxes or jars containing sandy soil supplied with fresh dung every few days.

These beetles, which are called "dung beetles" because they construct balls of dung in which to deposit their eggs, show many interesting variations in the manner of constructing and placing the balls and in caring for their developing brood. Some species dig a burrow, usually at the edge of cattle droppings, and carry the dung into it for the construction of the ball; others roll the ball first and then bury it. Most species form balls for adult food as well as egg balls. In some cases several balls are found in one burrow, while in others the egg balls are placed singly. Some species remain in the nest until the developing brood emerge as adults, while others desert their progeny after completing the egg ball. Females that remain in their nests will construct new nests if their progeny are removed.

Notes on the life histories of four of the most common coprophagous beetles—*Copris remotus*, *Phanaeus triangularis*, *Canthon laevis*, and *Onthophagus anthracinus*—are given.

Dung beetles are also attracted to carcasses and decayed meat. They are frequently found in bait pans of blowfly traps in southwestern Texas.

Because of their disturbance of cattle dung, the breeding medium of the horn fly (*Haematobia irritans*), dung beetles are believed to act as a natural control of this pest.

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